

WHAT IS CLAIMED IS:

1 1. An SPM system for making a modification to an object, the SPM system
2 comprising:
3 an SPM probe for making a modification to the object;
4 a positioning system to position the SPM modification probe with respect to
5 the object; and
6 a controller to control the positioning system such that (1) the modification of
7 the object is made with the SPM probe and particulate material is removed from the object
8 due to the modification, and (2) the SPM probe makes sweeping motions over the object to
9 sweep the particulate material away.

1 2. An SPM system as recited in claim 1 further comprising:
2 inspection components to make an inspection of the modification;
3 the sweeping motions of the SPM probe sweeping the debris material away
4 from where the modification was made so that the inspection components may inspect the
5 modification without obstruction.

1 3. An SPM system as recited in claim 2 wherein:
2 the inspection components include a second SPM probe to make the
3 inspection;
4 the positioning system positions the second SPM probe with respect to the
5 object; and
6 the controller further controls the positioning system such that the inspection
7 is made with the second SPM probe.

1 4. An SPM system as recited in claim 2 wherein:
2 the inspection components include the SPM probe; and
3 the controller further controls the positioning system such that the inspection
4 is made with the SPM probe.

1 5. An SPM system comprising:
2 an SPM probe for making a modification to the object;
3 a positioning system to position the SPM modification probe with respect to
4 the object; and

5 a controller to control the positioning system such that positioning of the SPM
6 probe with respect to the object is made by driving the positioning system simultaneously in
7 the X, Y, and Z dimensions.

1 6. An SPM system as recited in claim 5 wherein:
2 the SPM probe is used to make a modification to the object by performing a
3 cut in or milling the object;
4 the controller controls the positioning system such that the modification of the
5 object is made with the SPM probe by driving the positioning system simultaneously in the
6 X, Y, and Z dimensions.

1 7. An SPM system as recited in claim 5 wherein the controller drives the
2 positioning system simultaneously in the X, Y, and Z dimensions so that the motion of the
3 SPM probe in making the modification is a series of 3-D vectors.

1 8. An SPM system as recited in claim 7 wherein the motion defines a 3-D
2 vector, arc, curve, or surface.

1 9. A graphical user interface for rendering first measurement data and second
2 measurement data on a display, the first and second measurement data each comprising
3 measurement data points that each include first and second coordinate values representing a
4 position in a plane, each of the data points of the first measurement data further including a
5 measurement value representing a measurement of a first predefined measurement parameter,
6 each of the data points of the second measurement data further including a measurement
7 value representing a measurement of a second predefined measurement parameter, the
8 graphical user interface comprising:

9 a surface image generator to generate first image data from the first
10 measurement data and second image data from the second measurement data, the first image
11 data representing a 3-D first surface image of a first surface that extends along the plane and
12 is contoured based on the measurement values of the data points of the first measurement
13 data, the second image data representing a 3-D second surface image of a second surface that
14 extends along the plane and is contoured based on the measurement values of the data points
15 of the second measurement data; and

16 an overlay image generator to generate overlay image data by overlaying the
17 first and second image data, the overlay image data representing a 3-D overlay image of one

18 of the first and second surfaces overlaid on the other one of the first and second surfaces, the
19 overlay image being displayed by the display in response to the overlay image data.

1 10. A graphical user interface as recited in claim 9 wherein the first and
2 second predefined measurement parameters are different.

1 11. A graphical user interface as recited in claim 9 wherein the first and
2 second predefined measurement parameters are the same.

1 12. A graphical user interface as recited in claim 9 wherein the overlay image
2 generator comprises a separate surfaces image generator to generate the overlay image data
3 so that the overlay image comprises the second surface translucently overlaid on the first
4 surface.

1 13. A graphical user interface as recited in claim 12 further comprising:
2 an overlay controller to generate an offset value in response to a command
3 provided by a user with a user input device, the offset value representing a selected amount
4 of offset between the first and second surfaces; and
5 the separate surfaces image generator generating the overlay image data
6 further in response to the offset value so that the first and second surfaces appear offset by the
7 selected amount in the overlay image.

1 14. A graphical user interface as recited in claim 9 wherein the overlay image
2 generator comprises a separate surfaces image generator to generate the overlay image data
3 so that the overlay image comprises one of the first and second surfaces opaquely overlaid
4 on the other one of the first and second surfaces.

1 15. A graphical user interface as recited in claim 14 further comprising:
2 an overlay controller to generate an offset value in response to a command
3 provided by a user with a user input device, the offset value representing a selected amount
4 of offset between the first and second surfaces; and
5 the separate surfaces image generator generating the overlay image data
6 further in response to the offset value so that the first and second surfaces appear offset by the
7 selected amount in the overlay image.

1 16. A graphical user interface as recited in claim 9 wherein the overlay image
2 generator comprises a contiguous surface image generator to generate the overlay image data
3 so that the overlay image comprises a contiguous surface including first portions and second
4 portions that are connected together, the first portions comprising the portions of the first
5 surface that overlap the second surface and the second portions comprising the portions of the
6 second surface that overlap the first surface.

1 17. A graphical user interface as recited in claim 16 further comprising:
2 an overlay controller to generate an offset value in response to a command
3 provided by a user with a user input device, the offset value representing a selected amount of
4 offset between the first and second surfaces;
5 the contiguous surface image generator generating the overlay image data
6 further in response to the offset value so that the first and second surfaces are offset by the
7 selected amount and the first and second portions of the contiguous surface are altered in
8 response.

1 18. A graphical user interface for rendering first measurement data and
2 second measurement data on a display, the first and second measurement data each
3 comprising measurement data points that each include first and second coordinate values
4 representing a position in a plane, each of the data points of the first measurement data
5 further including a measurement value representing a measurement of a first predefined
6 measurement parameter, each of the data points of the second measurement data further
7 including a measurement value representing a measurement of a second predefined
8 measurement parameter, the graphical user interface comprising:

9 a surface image generator to generate base image data from the first
10 measurement data, the base image data representing a 3-D surface image of a surface that
11 extends along the plane and is contoured based on the measurement values of the data points
12 of the first measurement data,

13 an augmentation data generator to generate augmentation data from the second
14 measurement data, the augmentation data providing an augmentation of the surface based on
15 the measurement values of the data points of the second measurement data;

16 an augmented image generator to generate augmented image data by
17 augmenting the base image data with the augmentation data, the augmented image data
18 representing a 3-D augmented image of the surface augmented by the augmentation.

1 19. A graphical user interface as recited in claim 18 wherein the augmentation
2 data provides coloring of the surface.

1 20. A graphical user interface as recited in claim 18 wherein the augmentation
2 data provides texturing of the surface.

1 21. A graphical user interface for rendering on a display a 3-D composite
2 image of an object and a display tool embedded in the object, the graphical user interface
3 comprising:

4 an object image generator to generate object image data that represents a 3-D
5 object image of the object;

6 a display tool image generator to generate display tool image data based on the
7 object image, the display tool image data representing a 3-D display tool image of the display
8 tool; and

9 a composite image generator to generate composite image data by combining
10 the display tool image data and the object image data so that the composite image data
11 represents the composite image, the composite image being displayed by the display in
12 response to the composite image data.

1 22. A graphical user interface as recited in claim 21 wherein the display tool
2 image data is generated further in response to a command issued by a user with a user input
3 device to adjustably locate the display tool in 3-D in the object in the composite image.

1 23. A graphical user interface as recited in claim 21 wherein the 3-D
2 composite image of the object is of the volume of the object and the display tool is embedded
3 in and positionable in the volume of the object.

1 24. A graphical user interface as recited in claim 21 wherein the 3-D
2 composite image of the object is of the surface of the object and the display tool is embedded
3 in and positionable in the surface of the object.

1 25. An SPM system for inspecting and modifying an object, the SPM system
2 comprising:

3 SPM probes that include one or more inspection SPM probes and one or more
4 modification SPM probes;

inspection components to inspect the object by making SPM measurements with the one or more SPM inspection probes and to generate inspection results from the SPM measurements; and
modification components to modify the object with the one or more modification SPM probes based on the inspection results.

26. An SPM system as recited in claim 25 that further comprises:
calibration structures;
the inspection components calibrate the one or more inspection SPM probes for making the SPM measurements with ones of the calibration structures;
the modification components calibrate the one or more modification SPM probes for modifying the object using ones of the calibration structures.

27. An SPM system as recited in claim 25 wherein:
the inspection components and the modification components each include a scanning head;
the inspection components selectively load and unload the one or more inspection SPM probes to and from the scanning head of the inspection components to make the SPM measurements; and
the modification subsystem selectively loads and unloads the one or more modification SPM probes to and from the scanning head of the modification components to make the modifications to the object.

28. An SPM system as recited in claim 27 wherein the scanning head of the modification components and the scanning head of the inspection components are the same scanning head.

29. An SPM system as recited in claim 27 wherein the scanning head of the modification components and the scanning head of the inspection components are different scanning heads.

30. An SPM system for inspecting and modifying an object, the SPM system comprising:
SPM probes that include one or more inspection SPM probes and one or more modification probes for modifying the object;
inspection means for inspecting the object by making SPM measurements with

6 the one or more SPM inspection probes and generating inspection results from the SPM
7 measurements; and
8 modification means for modifying the object with the one or more
9 modification SPM probes based on the inspection results.

1 31. An SPM system as recited in claim 30 that further comprises:
2 calibration structures;
3 the inspection means calibrates the one or more inspection SPM probes for
4 making the SPM measurements with ones of the calibration structures;
5 the modification means calibrates the one or more modification SPM probes
6 for modifying the object using ones of the calibration structures.

1 32. An SPM system as recited in claim 30 wherein:
2 the inspection means and the modification means each include a scanning
3 head;
4 the inspection means selectively loads and unloads the one or more inspection
5 SPM probes to and from the scanning head of the inspection means to make the SPM
6 measurements; and
7 the modification means selectively loads and unloads the one or more
8 modification SPM probes to and from the scanning head of the modification means to make
9 the modifications to the object.

1 33. An SPM system as recited in claim 32 wherein the scanning head of the
2 modification components and the scanning head of the inspection components are the same
3 scanning head.

1 34. An SPM system as recited in claim 32 wherein the scanning head of the
2 modification means and the scanning head of the inspection means are different scanning
3 heads.

1 35. A method for inspecting and modifying an object, the method comprising
2 the steps of:
3 inspecting the object by making SPM measurements with one or more SPM
4 inspection probes;
5 generating inspection results from the SPM measurements; and

6 modifying the object with one or more modification SPM probes based on the
7 inspection results.

1 36. A method as recited in claim 35 that further comprises the steps of:
2 the inspection means calibrates the one or more inspection SPM probes for
3 making the SPM measurements with ones of the calibration structures;
4 the modification means calibrates the one or more modification SPM probes
5 for modifying the object using ones of the calibration structures.

1 37. A method as recited in claim 35 that further comprises the steps of:
2 selectively loading and unloading the one or more inspection SPM probes to
3 and from a scanning head to make the SPM measurements; and
4 selectively loading and unloading the one or more modification SPM probes to
5 and from a scanning head to make the modifications to the object.

1 38. A method as recited in claim 37 wherein the scanning head used in the
2 modifying step and the scanning head used in the inspecting step are the same scanning head.

1 39. A method as recited in claim 37 wherein wherein the scanning head used
2 in the modifying step and the scanning head used in the inspecting step are different scanning
3 heads.

1 40. An SPM probe that comprises:
2 an SPM tool with which to make the SPM measurements of or SPM
3 modifications to an object; and
4 a base that has an upper and lower surface and is connected to and surrounds
5 the SPM tool so that the SPM tool is located between the upper and lower surface and is
6 thereby protected from being damaged.

1 41. An SPM probe as recited in claim 40 further comprising:
2 an additional SPM tool with which to make SPM measurements of or SPM
3 modifications to an object;
4 the base being connected to and surrounding the additional SPM tool so that
5 the SPM tool is located between the upper and lower surface.

1 42. An SPM system that comprises:
2 an SPM probe comprising:
3 an SPM tool; and
4 a base that has an upper and lower surface and is connected to and
5 surrounds the SPM tool so that the SPM tool is located between the upper and lower surface
6 and is thereby protected from being damaged; and
7 components to make SPM measurements of or SPM modifications to an object
8 with the SPM tool.

1 43. An SPM system as recited in claim 42 wherein the SPM probe further
2 comprises:
3 an additional SPM tool;
4 the base being connected to and surrounding the additional SPM tool so that
5 the additional SPM tool is located between the upper and lower surface and is thereby
6 protected from being damaged;
7 the components also making SPM measurements of or SPM modifications to
8 an object with the additional SPM tool.

1 44. An SPM probe that comprises:
2 an SPM tool that has a cantilever and a tip on the cantilever; and
3 a base that has an upper and lower surface and surrounds the SPM tool;
4 the cantilever of the SPM tool being connected to the base so that the SPM
5 tool is located between the upper and lower surface when the cantilever is not bending, the
6 cantilever of the SPM tool being capable of being selectively bent back and forth by a tip
7 activation apparatus so as to selectively position the tip of the SPM tool below and above the
8 lower surface of the base whereby the tip of the SPM tool may be selectively activated and
9 deactivated for making SPM measurements or SPM modifications to an object and protected
10 from being damaged when deactivated.

1 45. An SPM probe as recited in claim 44 that further comprises the tip
2 activation apparatus.

1 46. An SPM probe as recited in claim 45 wherein:
2 the cantilever is conductive;
3 the tip activation apparatus comprises electrodes fixed to the base above and

4 below the cantilever;
5 whereby the cantilever is selectively bent back and forth by applying selected
6 voltages to the electrodes and the cantilever.

1 47. An SPM probe as recited in claim 44 further comprising:
2 an additional SPM tool having a cantilever and a tip on the cantilever; and
3 the cantilever of the additional SPM tool being connected to the base so that
4 the additional SPM tool is located between the upper and lower surface when the cantilever is
5 not bending, the cantilever of the additional SPM tool being capable of being selectively bent
6 down and up by a tip activation apparatus so as to selectively position the tip of the additional
7 SPM tool below and above the lower surface of the base whereby the tip of the additional
8 SPM tool may be selectively activated and deactivated for making SPM measurements of or
9 SPM modifications to an object and protected from being damaged when deactivated.

1 48. An SPM system that comprises:
2 an SPM probe that comprises:
3 an SPM tool that has a cantilever and a tip on the cantilever; and
4 a base that has an upper and lower surface and surrounds the SPM tool;
5 the cantilever of the SPM tool being connected to the base so that the SPM
6 tool is located between the upper and lower surface when the cantilever is not bending;
7 a tip activation apparatus to selectively cause the cantilever of the SPM
8 tool to be bent down and up so as to selectively position the tip of the SPM tool below and
9 above the lower surface of the base whereby the tip of the SPM tool may be selectively
10 activated for operation and deactivated for protection against being damaged;
11 components to make SPM measurements or SPM modifications to an object
12 with the SPM tool when the tip of the SPM tool is activated.

1 49. An SPM probe as recited in claim 48 wherein:
2 the tip activation apparatus comprises a pivot, a lever arm that pivots on the
3 pivot, and a lever arm movement mechanism;
4 whereby the cantilever of the SPM tool is selectively bent down and up by
5 causing the lever arm movement mechanism to selectively move a first end of the lever arm
6 up and down so that the lever arm pivots on the pivot and a second end of the lever arm
7 moves down and up while contacting the cantilever of the SPM tool.

1 50. An SPM system as recited in claim 48 wherein the SPM probe comprises
2 the tip activation apparatus.

1 51. An SPM probe as recited in claim 50 wherein:
2 the cantilever is conductive;
3 the tip activation apparatus comprises electrodes fixed to the base above and
4 below the cantilever;
5 whereby the cantilever is selectively bent back and forth by applying selected
6 voltages to the electrodes and the cantilever.

1 52. An SPM probe as recited in claim 48 further comprising:
2 an additional SPM tool having a cantilever and a tip on the cantilever; and
3 the cantilever of the additional SPM tool being connected to the base so that
4 the additional SPM tool is located between the upper and lower surface when the cantilever is
5 not bending, the cantilever of the additional SPM tool being capable of being selectively bent
6 back and forth by a tip activation apparatus so as to selectively position the tip of the
7 additional SPM tool below and above the lower surface of the base whereby the tip of the
8 additional SPM tool may be selectively activated and deactivated for making SPM
9 measurements of or SPM modifications to an object and protected from being damaged when
10 deactivated.

1 53. A microstructured force balance that comprises:
2 a base;
3 a contact platform;
4 a suspension system connected to the base and the contact platform to
5 displaceably suspend the contact platform over the base such that contact displacement of the
6 contact platform is caused when a contact force is applied to the contact platform via contact
7 with the contact platform; and
8 one or more displacement actuators to apply an actuator force to the contact
9 platform to cause actuator displacement of the contact platform with respect to the base;
10 wherein the contact and actuator forces are applied in opposite directions and
11 the contact and actuator displacements occur in opposite directions.

1 54. A microstructured force balance that comprises:
2 a base;

3 a contact platform;
4 a suspension system connected to the base and the contact platform to
5 displaceably suspend the contact platform over the base, the contact platform being displaced
6 by varying amounts of displacement when varying amounts of force are applied to the contact
7 platform by contacting the contact platform; and
8 a displacement actuator to selectively apply varying amounts of force to the
9 contact platform to selectively cause varying amounts of displacement of the contact platform
10 with respect to the base.

1 55. A microstructured force balance as recited in claim 53 wherein the
2 suspension system comprises spring arms connected to the contact platform and the base.

1 56. A microstructured force balance as recited in claim 53 wherein:
2 the suspension system displaceably suspends the contact platform over the
3 base for displacement in multiple dimensions;
4 the contact force has components in the multiple dimensions so that the
5 displacement of the contact platform is in first directions in the multiple dimensions;
6 the microstructured force balance further comprises multiple ones of the
7 displacement actuator to apply the force in second directions opposite to the first directions
8 and along the multiple axis of direction so that the actuator caused displacement and opposite
9 to selectively cause the varying amounts of displacement of the contact platform in the
10 multiple directions.

1 57. A microstructured force balance as recited in claim 54 wherein:
2 the suspension system displaceably suspends the contact platform over the
3 base in multiple directions;
4 the contact platform being displaced in the multiple directions by the varying
5 amounts of displacement when the varying amounts of force are applied to the contact
6 platform in the multiple directions by contacting the contact platform; and
7 the microstructured force balance further comprises multiple ones of the
8 displacement actuator to selectively apply the varying amounts of force in the multiple
9 directions to selectively cause the varying amounts of displacement of the contact platform in
10 the multiple directions.

1 58. A microstructured force balance as recited in claim 54 that further
2 comprises one or more displacement sensors to sense the varying amounts of displacement of
3 the contact platform.

1 59. A microstructured force balance as recited in claim 58 wherein:
2 the suspension system displaceably suspends the contact platform over the
3 base in multiple directions;
4 the contact platform being displaced by the varying amounts of displacement
5 in the multiple directions when the varying amounts of force are applied to the contact
6 platform in the multiple directions by contacting the contact platform;
7 the microstructured force balance further comprises multiple ones of the
8 displacement actuator to selectively apply the varying amounts of force in the multiple
9 directions to selectively cause the varying amounts of displacement of the contact platform in
10 the multiple directions; and
11 the microstructured force balance further comprises multiple ones of the
12 displacement sensor to sense the varying amounts of displacement of the contact platform in
13 the multiple directions.

1 60. A microstructured force balance as recited in claim 58 that further
2 comprises a control circuit located on the base, the control circuit being coupled to the
3 displacement actuator to control the displacement actuator to selectively apply the varying
4 amounts of force to the contact platform in response to displacement control signals, the
5 control circuit being coupled to the displacement sensor to generate displacement
6 measurement signals that provide a measure of the varying amounts of displacement of the
7 contact platform sensed by the displacement sensor.

1 61. A microstructured force balance as recited in claim 54 wherein:
2 the contact platform comprises a displaceable electrode that is displaced when
3 the contact platform is displaced; and
4 the displacement actuator comprises the displaceable electrode and a
5 stationary electrode fixedly coupled to the base such that the varying amounts of force
6 selectively applied to the contact platform by the displacement actuator are applied by
7 selectively applying voltages across the stationary and displaceable electrodes.

1 62. A microstructured force balance as recited in claim 58 wherein:
2 the contact platform comprises a displaceable electrode that is displaced when
3 the contact platform is displaced; and
4 the displacement sensor comprises the displaceable electrode and a stationary
5 electrode fixedly coupled to the base such that the varying amounts of displacement of the
6 contact platform are sensed by sensing voltage changes across the stationary and displaceable
7 electrodes.

1 63. A microstructured force balance as recited in claim 54 wherein:
2 the contact platform comprises a displaceable comb structure that is displaced
3 when the contact platform is displaced;
4 the displacement actuator comprises the displaceable comb structure and a
5 stationary comb structure fixedly coupled to the base such that the varying amounts of force
6 selectively applied to the contact platform by the displacement actuator are applied by
7 selectively applying voltages across the stationary and displaceable comb structures.

1 64. A microstructured force balance as recited in claim 58 wherein:
2 the contact platform comprises a displaceable comb structure that is displaced
3 when the contact platform is displaced; and
4 the displacement sensor comprises the displaceable comb structure and a
5 stationary comb structure fixedly coupled to the base such that the varying amounts of
6 displacement of the contact platform are sensed by sensing voltage changes across the
7 stationary and displaceable comb structures.

1 65. A force measurement system to measure a force applied by an item with
2 respect to displacement of the item, the force measurement system comprising:
3 a microstructured force balance that comprises:
4 a base;
5 a contact platform;
6 a suspension system connected to the base and the contact platform to
7 displaceably suspend the contact platform over the base, the displacement of the item causing
8 the force that causes a first displacement of the contact platform that is applied to the contact
9 platform by an item while the item contacts the contact platform; and
10 a displacement actuator to apply a force to the contact platform to cause a

11 second displacement of the contact platform with respect to the base;
12 system components to measure the force applied by the item by (a) causing the
13 displacement actuator to apply the force to the contact platform to cause the second
14 displacement of the contact platform, (b) measuring the first and second displacements and
15 determining when the first displacement has been nulled by the second displacement, and (c)
16 measuring the force applied by the displacement actuator when the first displacement has
17 been determined to have been nulled by the second displacement.

1 66. A force measurement system to measure a force applied to an item with
2 respect to displacement of the item and/or the displacement of the item with respect to the
3 force applied to the item, the system comprising:

4 a microstructured force balance that comprises:
5 a base;
6 a contact platform;
7 a suspension system connected to the base and the contact platform to
8 displaceably suspend the contact platform over the base; and
9 a displacement actuator to apply a force to the contact platform to cause
10 the displacement of the contact platform with respect to the base;

11 system components (a) cause the displacement actuator to apply the force to
12 the contact platform that cause the displacement of the contact platform, and (b) measure the
13 force applied to the item with respect to the displacement of the item and/or the displacement
14 of the item with respect to the force applied to the item.

1 67. A force measurement system to measure a contact force applied by an
2 item, the force measurement system comprises:

3 a microstructured force balance that comprises:
4 a base;
5 a contact platform;
6 a suspension system connected to the base and the contact platform to
7 displaceably suspend the contact platform over the base such that contact displacement of the
8 contact platform is caused when the contact force is applied by the item to the contact
9 platform via contact with the contact platform; and

10 one or more displacement actuators to apply an actuator force to the
11 contact platform to cause actuator displacement of the contact platform with respect to the

12 base;
13 the contact and actuator forces being applied in opposite directions and the
14 contact and actuator displacements occurring in opposite directions;
15 system components to measure the contact force by (a) causing the one or
16 more displacement actuators to apply the actuator force to the contact platform, (b) and (b)
17 measuring the actuator force when the contact displacement is nulled by the actuator
18 displacement.

1 68. A force measurement system to measure a force applied to an item, the
2 force measurement system comprising:
3 a microstructured force balance that comprises:
4 a base;
5 a contact platform;
6 a suspension system connected to the base and the contact platform to
7 displaceably suspend the contact platform over the base such that a force that causes a first
8 displacement of the contact platform is applied to the contact platform by an item while the
9 item contacts the contact platform; and
10 a displacement actuator to apply a force to the contact platform to cause a
11 second displacement of the contact platform with respect to the base;
12 system components to measure the force applied to an item by (a) causing the
13 displacement actuator to apply the force to the contact platform to cause the second
14 displacement of the contact platform, (b) measuring the first and second displacements and
15 determining when the first displacement has been nulled by the second displacement, and (c)
16 measuring the force applied by the displacement actuator when the first displacement has
17 been determined to have been nulled by the second displacement.

1 69. A system to measure displacement of an item with respect to a known
2 force applied to the item, the system comprising:
3 a microstructured force balance that comprises:
4 a base;
5 a contact platform;
6 a suspension system connected to the base and the contact platform to
7 displaceably suspend the contact platform over the base; and
8 a displacement actuator to apply a known force to the contact platform to

9 cause displacement of the contact platform with respect to the base which causes the
10 displacement of the item when the item is in contact with the contact platform; and
11 system components to (a) cause the displacement actuator to apply the known
12 force to the contact platform and (b) measure the displacement of the item.

1 70. A system to measure a force applied to an item with respect to
2 displacement of the item, the system comprising:
3 a microstructured force balance that comprises:
4 a base;
5 a contact platform;
6 a suspension system connected to the base and the contact platform to
7 displaceably suspend the contact platform over the base; and
8 a displacement actuator to apply a force to the contact platform to cause
9 displacement of the contact platform with respect to the base which causes the displacement
10 of the item when the item is in contact with the contact platform; and
11 system components to (a) cause the displacement actuator to apply the force to
12 the contact platform, (b) measure the force, and (c) measure the displacement of the item.

1 71. An SPM system to make SPM measurements of or SPM modifications to
2 an object, the SPM system comprising:
3 an SPM probe with a cantilever and a tip on the cantilever;
4 a positioning system to position the SPM probe;
5 a microstructured force balance that comprises:
6 a base;
7 a contact platform;
8 a suspension system connected to the base and the contact platform to
9 displaceably suspend the contact platform over the base; and
10 a displacement actuator to apply a force to the contact platform to cause
11 displacement of the contact platform with respect to the base;
12 positioning the contact platform such that a force that causes displacement of
13 the contact platform is applied to the contact platform by the SPM probe while the SPM
14 probe contacts the contact platform that nulls the displacement of the contact platform caused
15 by the force applied by the item system components to measure the force applied by the item
16 to the contact platform by (a) causing the displacement actuator to apply the force to the

17 contact platform to cause the displacement of the contact platform and (b) measuring when
18 the displacement caused by the force applied by the item has been nulled by the displacement
19 caused by the force applied by the displacement actuator.

1 72. A microstructured force balance as recited in claim 61 wherein the
2 moveable platform includes an obdurate contact plate on which contact is made in order to
3 displace the moveable platform.

1 73. A microstructured force balance as recited in claim 62 wherein the
2 moveable electrode comprises the obdurate contact plate.

1 74. A microstructured force balance as recited in claim 62 wherein the
2 moveable electrode comprises conductive diamond.

1 75. A microstructured force balance as recited in claim 62 wherein the
2 moveable electrode comprises conductive silicon carbide.

1 76. A microstructured force balance as recited in claim 62 wherein the
2 moveable electrode comprises conductive diamond like carbon.

1 77. A microstructured force balance as recited in claim 62 wherein the
2 moveable electrode comprises conductive carbon nitride.

1 78. A microstructured force balance as recited in claim 55 wherein:
2 the moveable platform comprises a moveable electrode; and
3 the one or more displacement actuators comprise a displacement actuator that
4 comprises the moveable electrode and a first stationary electrode fixedly coupled to the base
5 such that the varying amounts of displacement of the moveable platform are selectively
6 caused by applying selected voltages across the stationary electrode and the moveable
7 electrode;
8 the one or more displacement sensors comprise a displacement sensor that
9 comprises the moveable electrode and a second stationary electrode fixedly coupled to the
10 base such that the varying amounts of displacement of the moveable platform are sensed by
11 detecting voltage changes across the stationary electrode and the moveable electrode.

1 79. A microstructured force balance as recited in claim 54 wherein:
2 the moveable platform comprises a moveable comb structure;

3 the one or more displacement actuators comprise a displacement actuator that
4 comprises a moveable comb structure electrode and a stationary electrode fixedly coupled to
5 the base such that the varying amounts of displacement of the moveable platform are
6 selectively caused by applying selected voltages across the stationary electrode and the
7 moveable electrode.

1 80. A force measurement system to measure a force applied to or by an item,
2 the force measurement system comprising:

3 a microstructured force balance that comprises:

4 a base;

5 a contact platform;

6 a suspension system connected to the base and the contact platform to
7 displaceably suspend the contact platform over the base such that a force that causes
8 displacement of the contact platform is applied to the contact platform by an item while the
9 item contacts the contact platform; and

10 a displacement actuator to apply a force to the contact platform to cause
11 displacement of the contact platform with respect to the base that nulls the displacement of
12 the contact platform caused by the force applied by the item;

13 system components to measure the force applied by the item to the contact
14 platform by (a) causing the displacement actuator to apply the force to the contact platform to
15 cause the displacement of the contact platform and (b) measuring when the displacement
16 caused by the force applied by the item has been nullled by the displacement caused by the
17 force applied by the displacement actuator.

1 81. A force measurement system to measure a force applied to or by an item,
2 the force measurement system comprising:

3 a microstructured force balance that comprises:

4 a base;

5 a contact platform;

6 a suspension system connected to the base and the contact platform to
7 displaceably suspend the contact platform over the base such that a force that causes
8 displacement of the contact platform is applied to the contact platform by an item while the
9 item contacts the contact platform; and

10 a displacement actuator to apply a force to the contact platform to cause

11 displacement of the contact platform with respect to the base that nulls the displacement of
12 the contact platform caused by the force applied by the item;
13 system components to measure the force applied by the item to the contact
14 platform by (a) causing the displacement actuator to apply the force to the contact platform to
15 cause the displacement of the contact platform and (b) measuring when the displacement
16 caused by the force applied by the item has been nullled by the displacement caused by the
17 force applied by the displacement actuator.

1 82. A nanostructured force balance as recited in claim 54 wherein the
2 moveable platform includes an obdurate contact plate for making contact in order to displace
3 the moveable platform.

1 83. A nanostructured force balance as recited in claim 82 wherein the
2 moveable plate electrode is the obdurate contact plate.

1 84. A nanostructured force balance as recited in claim 83 wherein the
2 moveable plate electrode comprises conductive diamond.

1 85. A nanostructured force balance as recited in claim 83 wherein the
2 moveable plate electrode comprises conductive silicon carbide.

1 86. A nanostructured force balance as recited in claim 83 wherein the
2 moveable plate electrode comprises conductive diamond like carbon.

1 87. A nanostructured force balance as recited in claim 83 wherein the
2 moveable plate electrode comprises conductive carbon nitride.

1 88. An SPM system that comprises:
2 an SPM probe comprising:
3 a base with an aperture therein;
4 an SPM tool connected to the base and located within the aperture;
5 components to make an SPM measurement of or SPM modification to the
6 object with the SPM tool of the SPM probe; and
7 a vacuum source in fluid communication with the aperture in the base of the
8 SPM probe;
9 the components including a positioning system to position the probe with

10 respect to the object to maintain a gap between the object and the lower surface of the probe
11 so that the vacuum source causes a vacuum to be established in the gap while the SPM
12 measurement of or SPM modification to the object is made with the SPM tool of the SPM
13 probe.

1 89. A probe for delivering a fluid material to an object, the probe comprising:
2 a tip with a capillary;
3 a microstructured pump having an inlet to receive the fluid material and an
4 outlet in fluid communication with the capillary, the pump pumping the fluid material into
5 the capillary so that the fluid material is ejected by the capillary and delivered to the object in
6 response to a control signal received by the pump.

1 90. A probe as recited in claim 89 further comprising:
2 a base in which the pump is formed; and
3 a support platform connected to the base and on which the tip is located, the
4 support structure having a duct that connects the capillary of the tip and the outlet of the
5 pump.